

TITLE
EXHAUST GAS FLOW CIRCUIT AND DECHARGE UNIT FOR AN INTERNAL
COMBUSTION ENGINE

5 CROSS-REFERENCE TO RELATED APPLICATION

 This application claims the benefit of U. S. Provisional Application No.
60/439,676, filed January 13, 2003.

BACKGROUND OF THE INVENTION
10 The present invention relates generally to naturally aspirated internal combustion
engines and, in particular, to a decharge unit to improve low-end torque at wide open
throttle for a naturally aspirated engine.

 A continuing goal for naturally aspirated engines is to improve low-end torque.
Common methods for improving low-end torque involve installing a turbocharger or a
15 supercharger in the engine intake system. The use of these devices, however, leads to
high after-boost air temperature. An intercooler is then required to bring the air
temperature down to a more manageable temperature. In addition, by installing a
turbocharger or supercharger, the engine is no longer naturally aspirated. Another
problem is that of back pressure, or the pressure in the exhaust system that the engine
20 must overcome in order for the exhaust gas to flow through the exhaust system to
atmosphere. Turbochargers and superchargers located in the intake system do not
address the engine exhaust system back pressure. In addition, such turbochargers and
superchargers are expensive, and require modifications to both the exhaust system and
the intake system of the engine.

25 It is desirable, therefore, to provide a means for improving the low end torque for
a naturally aspirated engine by reducing the back pressure of the exhaust system. It is
also desirable to improve the low end torque of an internal combustion engine using
inexpensive components that do not require any modification to the intake system of the
engine.

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SUMMARY OF THE INVENTION

An exhaust gas flow circuit according to this invention reduces back pressure in the exhaust gas system of an internal combustion engine, increases the mass flow rate of fresh air into the combustion cylinders, provides good scavenging in the combustion
5 cylinders, and decreases the work required to pump exhaust gas from the engine through the exhaust system.

An exhaust gas flow circuit according to this invention includes a pumping unit, such as a gas compressor, for pumping exhaust gas from the engine exhaust system through an inlet to an outlet. A power source, such as an electric motor, drives the
10 pumping unit. A bypass passage is arranged in parallel flow relation with the pumping unit between the inlet and outlet. When the mass flow rate of exhaust gas is relatively high, a bypass valve opens the bypass passage, providing a flow path for exhaust gas between the inlet and outlet in parallel with the pumping unit. When the mass flow rate of exhaust gas is relatively low, the bypass valve closes the bypass passage. The bypass
15 valve can be controlled to open and close in response to engine speed, which is a measure of the exhaust gas mass flow rate.

The pumping unit and motor may be enclosed in a heat resistant housing to protect them from the high temperature environment of the exhaust system.

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DESCRIPTION OF THE DRAWING

The above, as well as other advantages of the present invention, will become readily apparent to those skilled in the art from the following detailed description of a preferred embodiment when considered in the light of the accompanying drawings in which:

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Fig. 1 is a schematic diagram of a decharge unit for a naturally aspirated engine in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to Fig. 1, a decharge unit in accordance with the present invention
30 is indicated generally at **10**. The decharge unit **10** is disposed in an exhaust system, indicated generally at **12**, of an internal combustion engine **14**. The engine **14** includes a plurality of combustion cylinders **16**, each of which is connected by an intake pipe **18** to

an intake plenum 20. The intake plenum 20 is connected at an open end to an air filter 21. Each of the combustion cylinders 16 is connected by an exhaust manifold 22 to the exhaust system 12. The exhaust system 12 includes a first catalytic converter or catalyst device 24, connected at an inlet thereof to the exhaust manifold 22. An inlet of a second catalyst device 26 is connected to an outlet of the first catalyst device 24. An outlet of the second catalyst device 26 is connected by an exhaust pipe 27 to an inlet 28 of the decharge unit 10. The first catalyst device 24, the second catalyst device 26 and the exhaust pipe 27 form a first or forward portion of the exhaust system 12.

The inlet 28 of the decharge unit 10 is connected to an inlet of a gas compressor or gas pump 30. The compressor 30 is preferably a heat resistant compressor that is able to withstand the heat of the exhaust gas, discussed in more detail below. The compressor 30 is powered by an electric motor 32, which is connected to an electrical power source (not shown). An outlet of the compressor 30 is connected to an outlet 34 of the decharge unit 10, which is connected to a discharge pipe 36. The discharge pipe 36 extends to a conventional rear exhaust system 44 that includes an exhaust muffler and exhaust outlet.

A bypass passage 38 extends between the discharge pipe 36 and the exhaust pipe 27. A bypass valve 40 is disposed in the bypass passage 38. Preferably, the decharge unit 10 is disposed in a housing 42 in order to protect the compressor 30 and the electric motor 32 from corrosion and possible foreign object damage. The discharge pipe 36 and rear exhaust system 44 form a second or rearward portion of the exhaust system 12.

In operation, air is inducted into the engine combustion cylinders 16 through the air filter 21, inlet plenum 20, and inlet piping 18. When the engine 14 is operated normally, air is mixed with fuel (not shown), and the air-fuel mixture is compressed by a piston (not shown), located in each combustion cylinder 16, and ignited, thereby producing exhaust gas. The exhaust gas is routed through the exhaust manifold 22, the first and second catalyst devices 24, 26 and to the inlet 28 of the decharge unit 10.

The compressor 30 of the decharge unit 10 pumps the exhaust gas from the exhaust system 12 to the rear exhaust system 44, thereby reducing the back pressure in the exhaust system 12 when the engine 14 is operating. When engine speed is relatively low, the bypass valve 40 is closed. When the operating speed of the engine 14 is relatively high and the engine is producing a larger exhaust gas mass flow rate than at low engine speed, the bypass valve 40 is opened. Then at least a portion of the exhaust

gas bypasses the decharge unit **10** so that the decharge unit **10** does not increase the back pressure of the exhaust system **12**. The electric motor **32** can be turned on and off with a control signal received on a line **46**. The control signal on the line **46** can be generated in any known manner based upon, for example, sensing the engine speed or the mass flow
5 rate of the exhaust gas in the exhaust system **12**.

By decreasing the back pressure in the exhaust system **12**, the decharge unit **10** according to the present invention increases the mass flow of fresh air into the combustion cylinders **16**, achieves good scavenging of the combustion cylinders **16**, and decreases the amount of pumping work of the engine **14**.

10 In accordance with the provisions of the patent statutes, the present invention has been described in what is considered to represent its preferred embodiment. However, it should be noted that the invention can be practiced otherwise than as specifically illustrated and described without departing from its spirit or scope.